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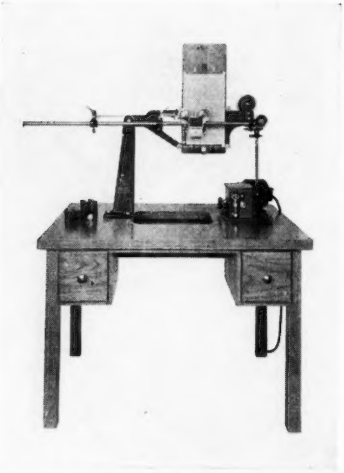

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The Annual Meeting

THE plans and program for the annual meeting, open research conference and annual dinner of the Institute at the Hotel Commodore, New York, N. Y., Thursday, Nov. 10, have been completed, with one important exception: That exception was to have been the first official and public presentation at the dinner of a new synthetic material. Unfortunately, just before this issue went to press it was learned that public announcement of this new material could not be postponed until Nov. 10. However, it may be possible to have presented at the dinner certain technical facts relating to this and other new synthetic textiles that are as yet unpublished.

The other features of the dinner program will be the annual address of President Elvin H. Killheffer, and an address by Fessenden S. Blanchard, chairman of the Institute's Committee on Economic Research, outlining the objectives of a new economic study to be conducted under the auspices of this committee and financed by The Textile Foundation. The title of this research is "Textile Inventory Policies and Statistical Guides." The agency for the conduct of the study will be announced at the dinner, and members of its staff introduced. This will be followed by a report on the results of the afternoon warp sizing conference.

Open Research Conference on Warp Sizing

The question of whether or not the warp sizing research, which has been in progress at Massachusetts Institute of Technology since the summer of 1935, shall be be reorganized and continued as a laboratory and mill study of the sizing of cotton and spun rayon warps and their sizing materials, will be discussed at an open conference to be held in Parlors B and C at 2 P. M. This conference is open to all who are interested in the subject, and is called at the request, at a meeting Sept. 9, of sponsors of the recently completed research on filament viscose warps. The sponsors were not only strongly in favor of a scientific study of cotton and spun rayon warp sizing, but felt that certain of the techniques and practical results of the filament viscose study would have practical application in its proposed new phase. They also strongly favored its conduct at a southern laboratory and in southern mills.

These are some of the subjects to be discussed at the open conference, the main objective of which is to learn from a representative number of those concerned and interested whether such a research is wanted, and whether there will be sufficient financial support likely to be forthcoming to justify the Institute in undertaking its organization and conduct on the co-operative basis.

W. E. Emley, chairman of the Institute's Research Council, will act as chairman of the conference. An outline report of the warp sizing study since its start in 1935 will be presented by members of its Administration Committee and Dr. W. E. Yelland, who directed the research.

The discussion will be led by Harold M. Chase, Superintendent of Dyeing, Riverside and Dan River Cotton Mills, Danville, Va., and Fred A. La Piana, Service Department, Stein, Hall & Co., New York, N. Y.

Those participating in the open discussion will not be stenographically reported by name, but the formal papers, and an outline report of the discussion will be made available for a Registration Fee of $2.00.

The Meeting Program

The hours and rooms for the various meetings are as follows:

11 A. M. (Parlors B and C).—Annual Meeting of members for presentation of formal reports and election of directors. (See Agenda, and list of directors whose terms will have expired.)

12:30 P. M. (Parlor A).—Luncheon Meeting of Directors.

2 P. M. (Parlors B and C).—Open conference on warp sizing Research.

7 P. M. (West Ball Room).—The annual dinner. Dress may be formal or informal.

Agenda for Annual Meeting

1.—Minutes of last meeting.
2.—Report of Board of Directors.
3.—Report of Treasurer.
4.—Report of Auditor.
5.—Report of Budget Committee.
6.—Report of Secretary.
7.—Report of Research Council.
8.—Report of Nominating Committee.
9.—Election of New Directors.
10.—New Business.

Directors Whose Terms Expire

The terms of the following directors expire in 1938, and a seventh director must be added in the place of Dr. E. H. Killheffer who is now an *ex-officio* member as president: Fessenden S. Blanchard, James T. Broadbent, Alban Eavenson, Ernest N. Hood, Weston Howland, Louis A. Olney.

Committees for Annual Meeting

Committee on Nominations: Ephraim Freedman, Chairman, Earl Constantine, Alban Eavenson, Dr. H. DeW. Smith, Douglas G. Woolf.

Budget Committee: Dr. H. DeW. Smith, Chairman, F. S. Blanchard, C. H. Clark.

Specifications of Test Samples Should be Complete and Accurate

By HARRY A. MERENESS*

Summary

It is urged that in all tests and researches having to do with finished broad goods, four kinds of information, now frequently omitted, be furnished:

1. *Yarn sizes.*
2. *Weight in ounces per square yard.*
3. *Breaking strength by both the "grab" and the "raveled strip" methods.*
4. *Yarn resistance to slippage.*

THE writer has spent the larger part of the last two years in compiling, comparing and analyzing data resulting from textile tests and researches. While some of this work has been of extreme interest, particularly from the standpoint of attempting to draw valid conclusions from seemingly unrelated data, much of the work has been pursued under very discouraging conditions because of the very general lack of specific description of samples tested. Frequently this has rendered it practically impossible to compare results from two different experiments, even when both have been done on the same type of fabrics. Obviously, if we can not reconstruct on paper the exact fabric from which the data were obtained, the individual results are of no value to anyone except the person having access to the sample.

Yarn Size Missing.—One of the most common omissions of fundamental data is that of the yarn size, especially when reporting on silk and rayon fabrics. Such data as "wash silk, pure dye, 180 x 112" can not give us an exact idea of the fabric tested. The complete data needed to identify the fabric would be something like the following: "pure dye silk crepe, 180 (warp ends) 2-ply 20/22 d. silk and 112 (filling yarns of) 3-thread 20/22 d. silk." For rayon fabrics we want to know whether the yarns are bright, dull or pigmented, and whether 75, 100, 150 or other denier in size.

In the case of the silk yarns it is not necessary usually to determine the yarn size by weighing, since we know that a 13/15 denier yarn contains 4 or 5 double filaments, and a 20/22 denier yarn 6 or 7 double filaments. When examining rayon yarns, after some practice a trained technician can tell, by comparison with a known 100 denier yarn, the size of the yarn being used. However, the twist in the filling yarns makes their determination more difficult than for the warp yarns which usually contain little twist.

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Weight per Square Yard.—The second item of importance frequently found missing from reports is the "weight in ounces per square yard." Obviously this figure should be established for the fabric after being subjected to standard conditions of humidity and temperature. But even if this can not be done, by all means give the weight per square yard as determined under ordinary conditions, making a note of the fact. This figure is particularly valuable in case the yarn sizes are not given.

Strip and Grab Figures for Breaking Strength.—A third suggestion is to give the breaking strength by both the "raveled strip" and the "grab" methods. The writer believes that where only one test can be made the grab method figures are to be preferred. Not only does the grab method give values which are more in accordance with the wear values, but the grab figures are more commonly available, since this method is used by most commercial testing laboratories.

An attempt was made with rather insufficient data to correlate strip and grab results (see *Tex. Rsch.*, March 1938). The conclusion was that we needed much more data to establish these relations on a firm foundation. One way to accumulate data rapidly would be for each worker to run both methods. This procedure is especially recommended to students doing work for college credits. The amount of additional material needed is but 240 sq. in. (five filling and five warp samples each 4 x 6").

Yarn Resistance to Slippage.—A fourth test, frequently found missing, is that of yarn resistance to slippage. This data is particularly useful in the case of rayon, woolen and silk fabrics.

It is a well known fact that for many fabrics, especially those used for underwear, and composed of smooth fibres, subject to laundering, and also for some of the very loosely woven woolen fabrics for outerwear, the ultimate utility of the garment is determined, not by the fabric becoming shabby, tearing, or wearing out, but rather by the fabric slipping at the seams, or the yarns shifting within the fabric.

To determine the resistance of a fabric to slippage there are needed five specimens, each 4 x 14", or a total of 280 square inches of material (see A. S. T. M., D434–36T). The apparatus needed is a standard pendulum type tensile strength tester with a maximum capacity of 50 pounds and equipped with an autographic recording device.

For many fabrics the resistance to slippage has been found to be the most significant single characteristic, as far as the usefulness of the fabric is concerned.

A Test of the Alternate Structures Proposed for Cellulose*

By S. T. GROSS and G. L. CLARK †

A Textile Foundation Publication

Foreword

THE greatest part of the investigation was directed toward a study of the unit cell of cellulose. The reasons for the selection of this problem are listed below:

1. The controversy between E. Sauter and Meyer and Mark, which concerns not only the nature of the unit cell, but also the arrangement of the chains within it, has made it necessary that independent investigations either confirm or reject the new cell.
2. The fundamental importance of the cellulose structure has been realized for some time, as is evidenced by the immense amount of effort expended in its study. A clear knowledge of this subject would permit a better understanding of all phases of cellulose chemistry, as well as of the physical properties.
3. The new powerful methods employed by Sauter in his investigation suggest application to other fibres or imperfectly oriented materials. The disagreement of data obtained by these methods, however, with that obtained by older but certainly reliable methods, must be explained before such application can be undertaken.
4. Reasoning analogous to that which led Sauter to contradict the structure of cellulose proposed by Meyer and Mark would also require new structures for some of the cellulose derivatives, and for rubber.

Summary

A number of oriental cellulose materials have been investigated in an effort to determine whether the unit cell for cellulose proposed by Sauter is more consistent with the x-ray evidence than that originally postulated by Meyer and Mark. A number of patterns have been made of tunicin, bacterial cellulose and valonia ventricosa. All patterns were consistent with the Meyer-Mark unit cell.

Introduction

RECENT PUBLICATIONS have offered a new unit cell and space structure for cellulose, which differs from that originally postulated by Meyer and Mark. The Meyer and Mark [1] unit cell has the dimensions: a = 8.35 A.U., b = 10.3 A.U., c = 7.95 A.U., = 84° while the

* This section has been submitted and will be published shortly in *Zeitschrift für Kristallographie.*

† Mr. Gross was a Fellow of The Textile Foundation working under the direction of Prof. George L. Clark, Department of Chemistry, University of Illinois.

cell proposed by Sauter [2] from experiments with ramie and bacterial cellulose, has the dimensions: a = 10.8 A.U., b = 10.4 A.U., c = 11.8 A.U., = 85°. The Meyer-Mark cell contains four glucose residues, while that of Sauter contains eight.

The two cells seem to be related in the a-c dimensions as shown in Fig. 1, and they have practically the same dimension in the direction of the b axis. In Table I are given the values for the Meyer-Mark unit cell calculated from those of Sauter, and also the values of Sponsler and Dore [3] who assumed nearly the same orientation as that in the more recent Sauter cell.

Most of the interferences possible in the Sauter cell will correspondingly occur in the Meyer-Mark cell, but in addition there will be other interferences. That is, such interferences as (u00) or (00u), where u is

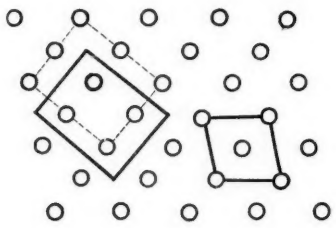


FIG. 1. The relation between the Sauter and Meyer-Mark unit cells in the a-c dimensions. The broken lines indicate the plane or planes of the glucose residues according to the investigator.

TABLE I

	a(A.U.)	b(A.U.)	c(A.U.)	
Sponsler and Dore	10.8	10.25	12.20	90°
Sauter	10.8	10.4	11.8	85°
Meyer-Mark cell calculated from Sauter dimensions	8.34	—	7.64	85°
Meyer-Mark cell	8.35	10.3	7.95	84°

an odd integer of the Sauter cell, cannot be present in that proposed by Meyer and Mark. Sauter takes the most intense interference in the cellulose pattern, A_4 by Meyer and Mark's earlier designation, as (003), and considers it to be a higher order of the intense A_1 interference which he designates (002). Meyer and Mark assign to A_4 the indices (002) and to A_1 (101)—this will not permit both reflections to arise from the same family of planes.

Sauter also claimed to have observed upon his patterns the presence of the (030) and (050) interferences, and has since published patterns obtained by rotating a block of fibres in an x-ray beam [4] to further substantiate his position. Since the space group C_2^2 selected by Meyer and Mark does not permit (0u0) reflections [5] the presence of such reflections would make

this choice of space group incorrect, and necessitate a different arrangement in the position of the glucose residues than that given by these authors.

Of these two points of controversy, the first seems to be the more important, since Meyer and Misch[6] expressly state that the (010), (030) or (050) interferences, if present, are so extremely weak that the arrangement of atoms postulated for their unit cell must be at least a good approximation. This would seem satisfactory since careful investigations[7, 8] have failed to disclose the presence of these interferences. The continuous darkening which overlies the layer lines in the cellulose fibre patterns make it very difficult to determine with certainty the presence or absence of (0u0) reflections.

The former point, however, which involves the most intense interference of the diffraction pattern is very important. If the A_1 interference occupies the position assigned to it by Sauter, a radical rearrangement must take place in the arrangement of the glucose residues in the cellulose chains, and a new spatial model must be sought. It must be noted that intensity considerations published by Meyer and Misch (loc. cit.) while not strictly quantitative lend support to the present model.

These experiments have been undertaken in an effort to explain this discrepancy, first through patterns made with Sauter's method upon biosynthetic cellulose preparations, and secondly through examination of other types of oriented cellulose by the same method.

Equipment

In investigations of this nature, where the orientation in the samples is not very perfect, a brief discussion of the equipment involved may be of some interest.

A camera of the type employed by Sauter[9, 10] was constructed from two motors such as are commonly used in electric clocks. One motor was arranged to rotate a pillar (holding the sample mounted in position with plasticine) at one revolution per hour in front of a flat disc (upon which the paper covered film was cemented) rotated at the same rate by the second motor. Excellent patterns were furnished both with single crystals and with oriented cellulose preparations. The camera is more flexible than that described by Sauter, since the two moving parts may be placed in any position relative to each other. The collimating system was designed for investigation of only the equatorial layer lines, although modifications are easily possible which would permit investigation of other layer lines. The sample-film distance was 3.8 cm., and filtered copper radiation was employed with Agfa film. Patterns were made in the position normal to the x-ray beam and also at an angle of about 30°. Exposures required from eight to thirty hours.

Since such a camera may also be used as an ordinary rotation camera, rotation patterns were made with the samples in position, and measurements from such patterns were used for interpretation of the results rather than the somewhat less accurate measurements from the goniometer patterns. Such rotation patterns required exposures of from three to five hours.

Patterns made by transmission through the three perpendicular directions of the oriented cellulose samples were used to determine the degree of orientation. Sauter-type patterns were made only on the specimens showing this to the highest extent.

All work was carried out with a Philips Metallix copper target diffraction tube, operated at 30 kilovolts and 20 milliamperes.

Materials and Preparation of Samples

The bacterial cellulose membranes employed in this investigation were furnished through the courtesy of Dr. W. A. Sisson of the Boyce Thompson Institute and Dr. Harold Hibbert of McGill University. Samples of both purified and unpurified material were available, but they produced identical patterns, at least as regards the stronger interferences. A number of methods were used to orient the material, i.e., by stretching a long thin band of the material as suggested by Meyer and Mark [11] or by varying the technique in manners suggested by the work of Sisson.[12] Rotation and transmission patterns enabled the selection of the most suitable materials.

Blocks approximately 0.4 x 0.4 mm. were constructed of the dried material, using the technique employed by Sponsler [13] in his work with the cellulose membrane valonia. The strips were examined between crossed Nicols on a microscope to insure their homogeneity before cementing together with the diluted collodion solution. All samples showed sharp extinction in the direction of stretching.

For experiments with tunicin the variety Ciona sp. was available. Since, according to Mark and Susich,[14] the (101) planes of the crystallites (using Meyer and Mark's indices) lie in the surface of the tunicin sheet, and since the 101 plane tends to orient normal to a constricting force as determined by Sisson (loc. cit.), sheets of the material as large as possible were used rather than narrow bands. This would tend to produce a constricting force normal to the surface of the tunicin sheet, and also prevent to some extent the development of forces in the surface which might tend to destroy the natural orientation. Samples of the purified tunicin * after orientation in this manner were examined as in the case of the bacterial cellulose, to determine which were the most suitable for goniometer patterns.

Theoretical and Experimental

The transmission, rotation and goniometer patterns to be expected from the Meyer-Mark unit cell are given in Fig. 2a. The nomenclature is identical with that used by Mark and Susich (loc. cit.), and the three transmission patterns correspond to those which they give for position I. Equivalent diagrams for the Sauter cell are given in Fig. 2b, deduced in the same manner as that employed by these investigators. For transmission patterns the column headings (D, Q and S) indicate the direction in which the beam entered the sample, but for the rotation and goniometer patterns it indicates the axis of rotation of the specimen. In both cases the accepted orientation has been used; the normal to the plane corresponding to the A_1 interference is perpendicular to the surface of the membrane and the b axis of the micelles lies parallel to the direction of stretching. Five different patterns in this series should make a distinction between the two unit cells.

Transmission patterns of bacterial cellulose along the direction of stretching (Fig. 3a) tend to favor the Sauter cell, but cannot be regarded as conclusive in any sense due to the obviously poor orientation. The

* The samples were purified in the manner suggested by E. Schmidt and G. Malyoth.[15]

length of the arc could easily include the positions required by the Meyer-Mark cell. The patterns in the other two dimensions (Figs. 3b and 3c) serve for a comparison of the orientation with that of the tunicin samples which follow, and also tend to indicate the Meyer-Mark cell when the intensities are considered.

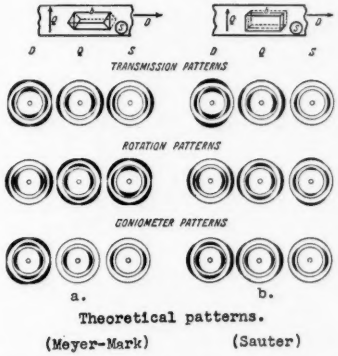
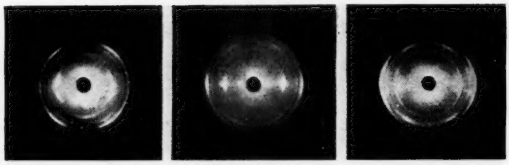


FIG. 2. D is the direction of stretching, Q the direction perpendicular to D and lying in the surface of the membrane. S is the direction normal to the surface of the membrane. Transmission patterns are made with the beam passing through the sample parallel to the direction indicated by the column heading. Rotation and Goniometer patterns are obtained by rotating the sample about an axis parallel to the direction indicated by the column heading.

FIG. 3. Transmission patterns through the three mutually perpendicular directions of a bacterial cellulose sample.

Transmission patterns from tunicin (Figs. 4a, 4b and 4c) exhibit a much higher degree of orientation. Some of the samples prepared from the variety Ciona sp. (see Fig. 5) show the orientation given by Mark and Susich upon material obtained from Phalusia mamillata, which were explained by assuming two positions for the crystallites in the membrane (loc. cit.). Other samples exhibit exactly the same orientation as that of bacterial cellulose, although in a somewhat higher degree. This is especially favorable for this investigation, since it is primarily the bacterial



a. b. c.

FIG. 4. Transmission patterns through the three mutually perpendicular directions of a tunicin sample (Ciona sp.).

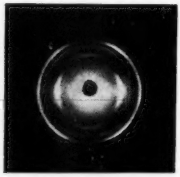


FIG. 5. Transmission pattern of Ciona sp. showing the orientation found by Mark and Susich with Phalusia mamillata.

cellulose patterns which are in question. The transmission patterns in this case, and especially Fig. 4a leave no doubt of the Meyer-Mark cell.

Bacterial cellulose oriented by simply fastening a strip tightly across the mouth of a beaker (Sisson, loc. cit.) and allowing the tension produced in drying to act as the orienting force, gives a pattern similar to Sauter's when the sample is rotated about the b-direction (or direction of stretching) in the goniometer (see Fig. 6a). The rotation pattern (Fig. 6d) in

a. b. c.

FIG. 6. Goniometer patterns of the equatorial layer line when the sample is rotated about its b or D axis. (Bacterial cellulose.)

this case is the ordinary fibre diagram of cellulose, with an orientation somewhat less than that of ramie. If the B-cellulose, however, is maintained at a tension somewhat less than that necessary to tear the material, during the entire process of drying, samples are obtained which on direct transmission show somewhat higher orientation, and Sauter-type patterns

about the b-direction then show the A_4 interference occupying the Meyer-Mark orientation (Fig. 6b) although with a considerable general scattering about the entire circle corresponding to the A_4 diffraction angle. If the material is rolled during the stretching process, an operation which

FIG. 6d. Rotation pattern of bacterial cellulose when sample is rotated about direction D.

might be expected to improve the orientation, the goniometer pattern still shows good orientation for the A_1 and A_2 interferences, but the A_4 interference again is almost continuous (Fig. 6e). If any segregation into arcs is noted it is favorable to the Meyer-Mark position. At the very least this must be accepted as making impossible the establishment of far-reaching conclusions upon the position of the A_4 intensity maxima.

Sauter's patterns obtained by rotation of the sample perpendicular to the b-direction and in the plane of the sample (about Q), show as strongest interference A_4 (Fig. 7a). Fig. 7a is identical with Sauter's pattern, even to showing a faint interference or darkening in the (030) position, so that the rotation pattern taken on this same sample (Fig. 7b) which shows A_4 a great deal more intense above and below the equatorial layer line than on the equatorial layer line itself, indicates that this A_4 interference does not belong on the goniometer-pattern at all, and thus again the pattern favors the Meyer-Mark cell.

Tunicin samples when rotated about the b-direction give the pattern in Fig. 8a. Here we have the theoretical pattern demanded for the Meyer-Mark cell, with a material which is known to be well orientated.

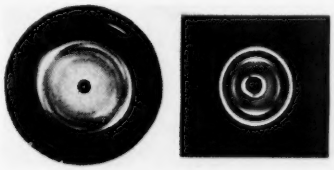


FIG. 7. Goniometer pattern of B-cellulose rotated about the Q direction, and rotation pattern of the same sample.

Rotation patterns only were prepared from valonia, since it is known that two orientations of the cellulose chains are present in the cell wall, at angles of from 60° to 80°.[16] The rotation in the plane of the cell wall gives the pattern in Fig. 9, which conforms to that expected from the Meyer-

Mark cell. Rotation in this dimension is not affected by the deviation in angle mentioned above.

When the entire group of patterns discussed above is examined, there is little doubt that either (a) the Sauter cell cannot explain the majority of these patterns and must therefore be incorrect, or (b) there may be more than one type of cellulose material. Consideration of the rotation pattern shown in Fig. 7b however, and that of the Sauter-type pattern obtained from cellulose maintained under tension (Figs. 6b and 6c) would indicate that the former of these two alternatives was the case.

Some explanation should be indicated for the pattern upon which the Sauter unit cell was based. Perhaps the essential point is that B-cellulose, before the membrane is deformed, shows a practically random orientation as indicated by the work of Sisson, and that stretching then tends not only to orient the b-directions of the micelles, but also tends to bring the (101) plane into coincidence with the plane of the specimen. It

FIG. 8. Goniometer pattern of Tunicin, sample rotated about D.

FIG. 9. Valonia rotation pattern made by cementing fragments of cell wall together with random orientation.

is to be expected that a large number of micelles would lie with their (101) planes rotated at some angle to the plane of the membrane, since the process is purely statistical. A 41° displacement of this type would permit the plane giving rise to the (002) interference to lie in the surface of the membrane. This would permit these reflections to fall in the region between the two theoretical maxima for (002) and produce patterns such as that under discussion. The length of the A_4 arc is very great compared with that of either the (101) interference or the $(10\bar{1})$ interference, and could therefore easily conceal the presence of the maxima reflected from those micelles which are well orientated.

In the case of the tunicin, however, the (101) planes are well oriented before deformation of the material, as noted by Mark and Susich, so that stretching would tend only to orient the b-directions of the micelles. The final sample should retain the original orientation of the (101) planes with little disturbance due to the deforming forces. In this case fewer (002) planes would be expected to lie in the surface of the membrane, and the A_4 interferences should then show the four maxima demanded by theory.

(*Continued on page 15.*)

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Comparative Insulative Values of Camel-Hair Versus Wool

By SYLVAN I. STROOCK *

IT has been generally known, for many years, that overcoats, topcoats and other outer apparel made of fine camel-hair cloth give to the wearer an indescribable and unusual comfort that has never been found in clothing made of fibres grown by any other animal. People learned that they could wear camel-hair garments lighter in weight and with more comfort than was possible with garments of heavier weight made of other fibres. They learned that camel-hair garments could be worn year 'round, in all climates and temperatures, with less burden, due to the high insulative value that camel-hair possesses, as compared with other fibres which enter into apparel usage.

To determine the actual reasons why camel-hair is a lesser conductor of heat than other animal fibres used for wearing apparel, a series of experiments were undertaken to determine the comparative insulative values of camel-hair with wool and with other animal fibres. This report does not determine the true conductivity constant of either wool or camel-hair fibres, or of the finished cloths made therefrom. It is on a comparative basis only; that is, a comparison of the conductivity of the wool used, with the conductivity of the camel-hair used, and of cloths made of wool compared with cloths made of camel-hair. The results of our tests all show that wool is a greater thermal conductor than camel-hair; or inversely, that camel-hair is a better insulator than wool.

To make a thorough investigation, actual tests were made on both wool and camel-hair fibres, in thirteen different conditions, namely:

(1) Fibres in the natural grease state; (2) scoured fibres; (3) fibres taken from the filling blend; (4) fibres taken from the warp blend; (5) fibres taken from the filling roving; (6) fibres taken from the warp roving; (7) fibres taken from the warp yarn; (8) fibres taken from the filling yarn; (9) fibres taken from the loom; (10) fibres taken from the fulling mill; (11) fibres taken from the scoured fabric after fulling; (12) fibres taken from the finished fabric; (13) tests on the fabric itself, both woolen and camel-hair cloths.

In addition, tests were made on the finished cloths, as follows: Camel-hair suiting vs. wool suiting cloth. Camel-hair velour coating vs. wool velour coating.

In order to establish a true basis of comparison, it became necessary to manufacture a camel-hair suiting cloth and a wool suiting cloth, of similar construction, yarn, weave, weight, and thickness; and a camel-hair velour coating cloth, and a wool coating cloth, to be similar in all the above respects (weight, weave, etc.).

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It was found impossible, however, to produce a woolen cloth and a camel-hair cloth to finish at the same thickness, if they were to be of the same weight. It was likewise found impossible to make them of uniform weight in corresponding constructions, with a total disregard for thickness, due to the fact that the natural characteristics of the fibres are different: Camel-hair and wool fibres each act differently under the different stages of processing. Each fulls or felts differently, stretches out differently after spinning, after weaving, and after scouring. Soaps, oils, and acids act differently upon each fibre. The absorptive properties of wool and camel-hair are unlike. The specific gravities of the fibres vary, camel-hair being 1.102; 12-month Texas wool, 1.25. Due to these many differences in the action of the two fibres, it was found to be impossible to make the camel-hair suiting cloth and the wool suiting cloth to correspond in weight and thickness. It was found equally impossible to produce velour coatings of wool and of camel-hair of equivalent weight and thickness, although every possible human effort was exerted during the manufacture of these special fabrics for the purposes of this study. Nevertheless, for the purpose, the wool cloths and the camel-hair cloths manufactured were sufficiently close to one another in weight and thickness, to enable comparative tests to be made; and by mathematical calculations the results were brought to a uniform basis.

The findings show that even though the wool cloths that were studied were heavier and thicker than the camel-hair cloths, camel-hair cloths both in suiting and coating proved to be better insulators. It is conceded that the insulative values within the fibres themselves are not the controlling or dominating factors in determining the insulative value of a cloth. The important factors which provide insulation in a fabric are mass, thickness, weight, construction, number of air spaces between the fibres, etc. It is, however, believed that, in addition to the mass, thickness, weight, air spaces, etc., the natural insulative properties *within the fibres* contribute to the total thermal conductivity, or insulative value, of a completed cloth.

The first series of tests were made on the fibres themselves in all stages, from the natural grease state right through to fibres taken from the finished cloth, including all thirteen stages enumerated. The second series of tests were made on finished cloths produced both from wool and from camel-hair. These tests were made under standard conditions, without consideration of the influence of outside temperature or changing moisture or wind. The next series of tests on cloth were made under varying climatic conditions, with due provision for temperature, moisture, wind or air pressure, etc., in order to see the results under normal conditions which relate to the wearing of garments.

The findings show camel-hair, in the fibre itself, to be from 50 to 65% a lower conductor, or better insulator, than the Texas wool. Tests on the finished cloths, as will be noted further in this report, show the camel-hair cloths to insulate better than the wool cloths under various climatic conditions, from 3.1 to 29% on the actual fabrics used; and if the wool and camel-hair materials had been uniform in weight, camel-hair cloth would range from 5.6 to 35% as a better insulator.

It should be noted that the insulative tests, for comparison between woolen and camel-hair cloths, were made under scientifically controlled conditions, and likewise under outside natural conditions; i.e., different temperatures, altitudes, winds, and humidities; and all of the tests under

these variable conditions in which clothing is worn, have shown that the camel-hair cloths tested were better insulators than the wool cloths.

This difference in the insulating power, or heat conductivity of indivual fibres and of the cloths produced from them, is due to several factors, such as the effect that chemicals, oils, soaps have upon cloths in process. It is also due to the variance in quantity and size of air spaces in the cloths; likewise to the fact that in the tests made on the fibres the heat traveled horizontally along the fibres; whereas, in the tests made on finished cloth, the heat to a very great extent traveled across the fibres, or at right angles to the length of the fibre. These factors account for the higher percentage of insulation possessed by the fibres themselves as against the cloths. The great importance of texture, mass, and other characteristics in fabrics, in making them insulative, is also brought out. At the same time, these results do show that in spite of these wide variations in texture, etc., the camel-hair cloths are better insulators than the woolen cloths.

While the complete range of tests upon which this report is predicated comprises those made between camel-hair and 12-month Texas wool, it should be mentioned that an additional extensive series of tests were made on other wools and hairs, all of the same diameter, 21.6 microns (Australian wool, Ohio wool, California wool, mohair, alpaca, and llama); and in all cases the camel-hair proved to be a lower conductor, or inversely, a better insulator than any or all of these other fibres.

It was found that fibres of camel-hair and of wool showed different net results in insulative value under each different stage of manufacturing process. This is attributed to the change in fibre formation caused by the spinning of the fibre, as well as to changes that occur in formation under the weaving operation and during fulling, and again under scouring. These changes are due in part to the difference in the stretching of the fibres. It is felt, however, that the figures which were established upon the fibres during different stages of processing, are irrelevant; that the matter for concern is solely with the insulative values of the fibres in their natural state before processing, and then again with the fibres taken from the finished fabrics; lastly, with the cloths.

Insofar as the determinations of the thermal conductivity of the camel-hair fibres and the wool fibres are concerned, it was found necessary to have special apparatus constructed. The equipment was made by the Parker Engineering Company, under the supervision of Mr. Rufus Caldwell, radio engineer, who has had considerable experience in this field. In making the tests every factor was kept the same, so far as diameter and length of fibre, room temperature and light, are concerned. The machine was carefully calibrated, and in order to test its efficiency, determinations were made upon other materials of known conductivity, such as spun-glass and cellulose. These were also of the same diameter as the camel-hair and wool fibres. The tests were made under as carefully controlled conditions as was humanly possible, and every precaution taken to see that the results were entirely comparable.

To summarize on the insulative values of the fibres, our findings show that, before processing, the insulative value of the camel-hair was about 65% greater than the Texas wool; and on fibres taken from the finished cloths, the camel-hair was approximately a 50% better insulator than the wool.

All tests on the fibres were made under the supervision of Dr. A. C. Whitford, B.S., Ph.D., and research chemist, with the assistance of Dr. Rufus Caldwell, radio engineer.

Tests on the cloth were made by The J. L. Finck Laboratories of New York City, under the direction of J. L. Finck, Ph.D., physicist and specialist on heat insulation; by Macy's Bureau of Standards, under the supervision of the director, Mr. Ephraim Freedman, and by Dr. Whitford.

Report of the J. L. Finck Laboratories

Tests were made by The J. L. Finck Laboratories under conditions as laid out by the U. S. Bureau of Standards, using the standard flat hot plate apparatus with guard ring. The hot plate was placed in a horizontal position and each test sample was placed directly on the plate. Above the sample was placed a cold plate with an air space of about one inch, separating the cold plate from the sample. The hot and cold plates were each maintained at constant temperature.

The results show camel-hair velour to be a 12% better insulator than the wool velour, and the camel-hair suiting a 7% better insulator than the wool suiting. Of course, these tests do not consider the influence of changing temperature, moisture, wind and other outside conditions.

Report of Macy's Bureau of Standards

The report of the tests made by Macy's Bureau of Standards is as follows:

"1. Given two fabrics constructed by taking fibres of identical diameter, spinning these fibres into yarns of the same yarn number, and subsequently weaving these yarns into cloths of the same cloth count, camel-hair will be found to be a better thermal insulator than wool.

"2. Given two fabrics constructed by taking fibres of identical weight and spinning these fibres into yarns of the same yarn number, and subsequently weaving the yarns into cloths of the same cloth count, camel-hair will be found to be a better thermal insulator than wool.

"3. Given two fabrics constructed either by taking fibres of identical diameter or of identical weight, spinning these fibres into yarns of the same yarn number, and subsequently weaving these yarns into cloths of the same cloth count, and fulling these cloths, camel-hair will be a somewhat but not much better thermal insulator than wool."

The Whitford Tests

Dr. Whitford's tests as to the insulative power of various cloths were undertaken under varying climatic conditions so as to determine the effects of temperature, wind, sun, moisture, and other conditions under which garments are worn. The apparatus used in the Finck Laboratory tests was not suitable for this purpose; therefore, the so-called "can method," which consists of cans identical in size and construction, was resorted to. Precautions were taken against loss of heat or change in temperature, excepting through the cloths. In order to do this, 1½-inch cork tops and bottoms were used, and a coarse mesh, fine wire screen was attached about ½-inch from the body of the can, so that the nap of the cloth would not

come into contact with the metal. These cans were of a size to permit their easy transfer from place to place, and their use either inside a room, or out of doors where conditions would be like those to which people are subjected.

To be certain of the accuracy of these tests, they were run three hours in each case; and the tests on each cloth, under all conditions, were run at least three or more times, in order to establish accurate determinations.

These tests were also run in three different localities, so as to determine the difference in climatic conditions, viz.: Miami, Fla., New York City, Alfred, N. Y. The resulting figures, it should be noted, are given on the following basis: Comparison of the actual cloths, disregarding the fact that in each case the wool cloths were both thicker and heavier than the camel-hair and therefore had these two advantages.

The tests in New York City were made as follows: With an outside temperature of 49°, sky clear, and with a North wind. In this case, the camel-hair velour coating was found to be a 6.6% better insulator than the wool coating, and the camel-hair suiting a 6% better insulator than the wool suiting. In each case, it must be remembered that the wool velour was 12.1-ozs. to the square yard, whereas the camel-hair was only 11.4-ozs. to the square yard. The wool suiting was 9 ounces, and the camel-hair suiting 7.5-ozs. to the square yard. In spite of this difference in weight and thickness, the figures given above were obtained.

It was then decided to convert these percentages to a basis where the camel-hair and the wool cloths are identical in weight. Both the wool velour coating and the camel-hair velour coating were calculated to 12-ozs. per square yard; and on that basis, the camel-hair becomes an 8.6% better insulator. The camel-hair and wool suitings were then figured, both to a 9-oz. per sq. yard basis; and in this weight the camel-hair suiting is shown to be a 9.9% better insulator than the wool suiting.

In a second series of tests carried on in New York, with the thermometer at 38° F., no wind, a cloudy sky and snow, the camel-hair velour proved to be a 5.5% better insulator on an average of three tests; and the camel-hair suiting, a 3.8% better insulator than the wool suiting. Applying the same calculations as above to bring these cloths to uniform weights, it was found that the camel-hair coating was a 6.4% better insulator than the wool coating, and the camel-hair suiting was a 7.9% better insulator.

In the third series of tests conducted in New York, when the thermometer stood at 40°, there was a strong northeast wind blowing with a mist in the air, such that the relative humidity was approximately 95. The camel-hair velour coating was a 13.8% better insulator than the wool coating, and the camel-hair suiting a 13.6% better insulator than the wool suiting. Again, bringing these cloths to the same weight, namely, the coating to 12-ozs. to the square yard, camel-hair velour coating is a 16.3% better insulator; and the camel-hair suiting, based on a 9-oz. per sq. yard weight, is a 21.5% better insulator.

In this series of tests, the influence of wind and moisture is the important factor, and it shows very decidedly the greater insulative power of camel-hair cloth over wool cloth under conditions where warmth without excessive weight is especially desired.

It is maintained that this difference in thermal conductivity, in favor of camel-hair, is attributable to the difference in (1) physical structure of

the fibres (2) their comparative water absorptive properties; and because of the fact that (3) there are more air spaces in camel-hair cloth than in wool cloth.

A study of camel-hair fibre and wool fibre, under high magnification, makes evident the reason for the greater insulative power of camel-hair. Wool has very many more scales than camel-hair. On the wool fibre, the scales project away from the shaft of the fibre and the shaft itself is much smaller than that of camel-hair. The attachment of the wool scale to the shaft is much smaller than the attachment of the camel-hair scale to the shaft. The wool scale is roughly triangular, with the apex of the triangle attached to the shaft of the fibre; while camel-hair is more or less rectangular in shape, with the point of attachment to the shaft very broad and more or less wrapped around its shaft. Furthermore, on camel-hair, there was found to be a layer or outer wall on the outside of the hair which covers the scale. In fact, the scale on camel-hair seems hardly to protrude through to the surface of the fibre; whereas, on wool, the scales are clearly apparent and protrude beyond the outer surface. In camel-hair, it is thought to be the outer layer which renders the fibre smooth and glossy; whereas the projecting scales on the wool fibre give it its serrated character. These projections on wool catch and entrap the air; whereas camel-hair, being smooth and without projections, does not act in this manner.

A study of 12-month Texas wool fibre shows approximately 2375 scales to the inch, each scale having approximately four appendages. Therefore, there are almost 10,000 serrations to the inch in this wool. This point is stressed to bring out the difference in physical structure of both camel-hair and wool fibres and the direct bearing which it has upon the insulative value of the finished cloths.

A series of tests were also run in New York City, with the cans filled with ice-water, to determine not only how rapidly cold would penetrate the cloths, but also how rapidly heat would penetrate. In this series, the temperature was kept at 75° F., and there was no wind or atmospheric disturbance. It was found that the camel-hair velour was a 29% lower conductor of heat than wool velour; and that if the cloths were of the same weight, namely 12-ozs. to the square yard, the camel-hair velour would be a 31.4% lower conductor. Under the same conditions, it was found that the camel-hair suiting is a 29% lower conductor of heat; and when figured to an identical basis of weight, camel-hair suiting is a 35% lower conductor of heat.

A series of tests, comparable to those in New York, were then run in Miami, Florida, with the following results: With the thermometer standing at 77° F., and a bright sun, it was found that the camel-hair velour was a 13.8% better insulator than wool velour; and when the cloths were figured to the same weight basis, namely 12-ozs. to the sq. yard, the camel-hair velour was a 15.4% better insulator. Under the same conditions, the camel-hair suiting was a 22% better insulator than the wool suiting; and when both cloths were figured to a basis of 9-ozs. to the square yard, camel-hair suiting was a 26.9% better insulator. In this series of tests, a strong east wind was blowing, which again shows the greater insulative value of camel-hair on a windy day.

When a second series of tests were conducted in Miami, using ice-water in the cans to determine the comparative power of camel-hair cloths and wool cloths to keep heat out, the cans were placed in the bright sun which

showed a thermometer reading of 110° F. Under these conditions, the camel-hair velour proved to be a 13.7% poorer conductor of heat than wool, and the camel-hair suiting a 13.6% poorer conductor of heat. When figured on the same basis of thickness, the wool velour proved to be a 14.6% better conductor of heat; and the camel-hair suiting, when the cloths were figured to a basis of 9-ozs. to the square yard, a 16.7% poorer conductor of heat than the wool suiting.

The third series of tests were run at Alfred, N. Y., which has an altitude of 1795 ft., to determine the effect of a normally dry atmosphere. In the first test run, when the thermometer stood at 82° and there was a mild southwest wind blowing, the camel-hair velour proved to be a 4.3% better insulator than wool velour; and when these cloths were figured to a basis of 12-ozs. per sq. yard, the camel-hair velour proved to be a 7.1% better insulator than the wool velour. The camel-hair suiting, under identical conditions, proved to be a 5.4% better insulator than the wool suiting; and when these cloths were figured on a basis of 9-ozs. to the sq. yard, the camel-hair suiting proved to be a 10% better insulator than the wool suiting.

In the second test, with the thermometer standing at 36° F., a slight snow falling and no wind, the camel-hair velour was a 3.1% better insulator than the wool velour; and when figured to a basis of 12-ozs. to the sq. yard, the camel-hair velour was a 5.6% better insulator. Under the same conditions, camel-hair suiting proved to be a 3.2% better insulator than the wool suiting; and when these were figured on a basis of 9-ozs. to the sq. yard, the camel-hair suiting was a 10.2% better insulator than the wool suiting.

A series of tests were also run at Alfred, using ice-water in the cans to determine the ability to keep heat out. The thermometer in this case stood at 88° in the bright sun, and the humidity was very low. It was found that the camel-hair velour was a 15.8% poorer conductor than the wool velour; and when the cloths were figured to a basis of 12-ozs. to the yard, the camel-hair velour was an 18.2% poorer conductor of heat than the wool velour. Under the same conditions, it was found that the camel-hair suiting is an 18.2% poorer conductor of heat than the wool suiting; and when figured on the basis of 9-ozs. to the sq. yard, the camel-hair suiting was a 27.1% poorer conductor of heat than the wool suiting.

In addition to the tests described above, velour cloths of similar weights, constructed 50% of camel-hair and 50% of wool, showed insulative values approximately half way between those of an all-wool cloth and an all camel-hair cloth. As an example, on one test, with an outside temperature of 34° F., sky cloudy and a light snow falling, the camel-hair velour lost 19.8% of the total amount of heat possible. The Texas wool velour lost 25.3% of the total amount; and a velour composed 50% of Texas wool and 50% of camel-hair noil, lost 22.9% of the total. If these were figured on a basis of 12-ozs. to the sq. yard, camel-hair velour lost 18.8%, Texas wool, 25.5%, and the 50% camel-hair and 50% Texas wool, 22.5%. This illustrates the value of camel-hair as an insulating material in cloths of similar construction.

Comparative Thermal Conductivity

Besides the fibres tested, as stated in this report, the thermal conductivity of other fibres was determined, to establish the comparative conductivity as based on camel-hair at 100. These were as follows:

Llama	130.1	Mohair fleece	175.7
Texas wool	165.5	Ohio wool	181.8
Kashmir noils	165.5	California wool	190.9
Australian wool	169.7	Mohair noil	151.5

Comparative Hygroscopicity

Tests were made on the 12-month Texas wool and camel-hair, as to water absorptive and retentive powers, and it was found that the wool absorbed 218% of its own weight; camel-hair, 116.5% of its own weight.

Specific Gravity Determinations

Fibre		*Fabric*	
Texas wool	1.25%	Camel-hair velour	1.24
Camel-hair noils	1.102%	Wool velour	1.35
Camel-hair fleece	1.121%	Camel-hair suiting	1.13
Mohair fleece	1.29%	Wool suiting	1.26

These determinations were established by methods recommended by the International Critical Tables, Vol. II:

Thickness of Fabrics Used

Camel-hair suiting	0.045 in.	Camel-hair coating	0.1023 in.
Wool suiting	0.055 in.	Wool coating	0.1445 in.

Fibres to the Square Inch

Camel-hair coating:

26% more fibres to the square in. than wool

Camel-hair	14,620	fibres per sq. in.
Wool velour	11,606	" " " "

Camel-hair suiting:

42% more fibres to the square in. than wool suiting.

Camel-hair	12,132	fibres per sq. in.
Wool suiting	8,531	" " " "

Worked out by mathematical calculation to uniform thickness, camel-hair coating has 61% more fibres to the square inch than wool coating; camel-hair suiting has 69% more fibres to the square inch than wool suiting.

Count of number of fibres on the face of the fabric shows the following: camel-hair coating, approximately 9% more fibres than wool. Camel-hair velour, 7356 fibres per sq. in.; wool velour, 6772 fibres per sq. in.

The scientific data established to arrive at the conclusions described herein are on file and will be made available to anyone who wishes to inspect the methods used in obtaining these results.

Abstracts

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I. Fibres (Synthetic and Natural) and Fibre Analysis

Keratin Fibres. Wm. Harrison. *Am. Dye. Rptr.*, July 11, 1938, P. 393–406.

A communication to the Research Committee of A. A. T. C. C. discussing existing basic knowledge and theory as to the chemical and physical properties of keratin fibres, with particular reference to recently published differences of opinion expressed by J. B. Speakman (*Am. Dye. Rptr.*, April 4, 1938, P. 168–71) and Sookne and Harris (*Am. Dye. Rptr.*, Nov. 1, 1937, P. 659). The author has made a wide study of keratin fibres. The points discussed in this article are summarized as follows:

(1) Since only a fraction of the substance of keratin fibres is in a true or approximately true crystalline state the properties of hair and wool can at the most be only partially influenced by the crystalline form; (2) that the changes in the X-ray spectra which can be produced in hair and wool in a variety of ways are not directly related to their elastic properties; (3) that the transformation from one crystal form to another is most likely due to the deformation of crystals of rectangular form to crystals of monoclinic form of the same length of sides and vice versa; (4) that statement (3) accounts satisfactorily for the fact that the change in crystal form can be produced by stretching lengthways, by compressing widthways and by chemical treatment resulting in lengthways shrinkage; (5) that the hypothesis of extensible molecular chains advanced by Astbury and his co-

workers was deduced from inconclusive and insufficient evidence, is untenable, and does not explain all the known facts; (6) that the idea that the molecule of keratin in normal unstrained hair and wool has contractile properties is unsupported by any conclusive evidence and is untenable; (7) that the elastic properties of keratin fibres modified by the action of caustic soda or of steam under certain conditions, is not the true elasticity possessed by rubber but is osmotic elasticity largely influenced by the absorption and desorption of water by the proteins within the fibre and within the unit cells of the fibre; (8) that the properties of wool are accounted for by Speakman's theory according to which the elasticity is controlled by elastic cell-walls while the "plasticity" is controlled by the fibrillar contents of these cells as well as by the viscous or colloidal interfibrillar substances; (9) that super-contraction is not due to the presence of contractile chains in keratin fibres but is due to the interaction of the elastic cell-walls and their swellable contents, and is a special case of swelling phenomena; (10) that super-contraction takes place in two general ways, one accompanied by swelling and associated with the osmotic elasticity and the other accompanied by volumetric contraction of the swollen protein, both resulting in lengthways shrinkage; (11) that the change in crystal form which is produced when keratin fibres are super-contracted by sodium bisulfite agrees with a change from oriented rectangular crystals to monoclinic crystals having the same symmetry as disoriented rectangular crystals and leading to a shortening of the crystals by 33⅓% in the direction of the fibre axis; (12) that permanent set is not due to or controlled by the conversion of alpha keratin to beta keratin although frequently accompanied by this change in the small fraction of crystalline proteins nor is it due to the rebuilding of side linkages between contractile molecular chains in these crystalline proteins which represent only a small fraction of the whole fibre; (13) that permanent set is due to two general causes, one due to the weakening of elastic cell-walls or other structures normally resisting extension and the other due to coagulation or setting of the colloidal cell contents while the fibre is held in a stretched condition; (14) that chemical reactions play an important part in all the swelling and deswelling phenomena associated with keratins and only in that way do such chemical reactions play a part in super-contraction, permanent set and in other properties of the keratin fibres. (C)

MERINO FLEECE. III. YIELD OF FLEECE WOOLS. Martin R. Freney and Helen Newton Turner. *J. T. I.*, June 1938, P. T132–T144.

The arguments advanced by the authors show that when yield is calculated as a percentage which is in any way based on the air dry weight of either scoured or fleece wools, the relative humidity at the time of weighing must be known before the amount of dry wool in any sample can be determined. From yields based on dry weights or on specified conditioned weight, however, the amount of dry wool in a sample may be determined without reference to relative humidity. It is suggested that for scientific purposes yield should be estimated in this manner. The authors admit that it may be necessary sometimes, for purposes of expediency, for those interested in research on sheep and wool to rely on yields which are estimated manually. If these yields are actually based on anything except dry or conditioned weights, the extent to which they may vary must be clearly realized before they are interpreted for scientific purposes. That is the

reason for their presentation of this paper and they wish it to be clearly understood that it is not their object to criticize destructively the yields estimated by the practical man such as the wool classer and wool buyer. No tests of the yields estimated by these practical men have been carried out in connection with the present work, and no results of such tests have been published. It is evident that the definition of these yields, and of the accuracy with which they can be estimated, can be determined only by carefully planned experiments. (C)

PAPAIN: APPLICATION IN DEGUMMING OF SILK. H. Münch. *Mell. Textilber., English Ed.*, 1938, V. 18, P. 37–40; abs. in *J. T. I.*, April 1938, P. A213.

The injurious action of soap degumming baths on cellulose acetate rayon and wool in the treatment of mixture fabrics containing these fibres and silk is pointed out and the advantages of the use of papain instead of soap are discussed. (C)

II. YARNS AND FABRICS

PREPARING LONG WOOLS. Anon. *Wool Rec. & Text. Wld.*, Aug. 11, 1938, P. 37–9.

The demand for a prepared top which compares favorably in every way with its carded counterpart has led to the introduction of complications into the one-time straightforward preparing processes. Correct and efficient technique for the various processes is described. (C)

RAYON AND STAPLE FIBRE YARNS: DIFFICULTIES CAUSED BY USE OF—AS EFFECT THREADS IN WOOLEN FABRICS. H. Förster. *Mell. Textilber.* (German ed.), 1938, No. 8, P. 641.

Difficulties are often met with not only in manufacture, but also in wear. The author shows how to prevent these troubles and gives a number of general hints on how to secure woolen goods with effect threads that do not show any defects. (C)

REEDS: ADVANTAGES OF CHROMIUM-PLATED REEDS. H. E. Wenrich. *Rayon Tex. Mo.*, July 1938, P. 59–60. (C)

SPEED LIMIT IN SPINNING. Fred Anders. *Tex. Wld.*, July 1938, P. 42–4.

As a result of his study of the woolen ring-spinning process, the author has developed some new and interesting theories regarding the speeds at which the frames can be run to obtain maximum production without impairing the quality of the yarn. (C)

SPINNING OF STAPLE FIBRE: PROBLEMS OF. *Mell. Textilber.* (German ed.), 1938, No. 8, P. 626.

It has hitherto been customary for each type of fibre to develop its own special spinning process, because that is the only way by which it is possible to bring out the characteristic properties of the fibres in the finished yarn. It is, therefore, to be expected that staple fibre will go its own way in future also. It cannot be the correct procedure to run staple fibre through cleaning machines, as is done for example in spinning cotton, although no cleaning is necessary, but only loosening up. It is also conceivable that much of the staple fibre produced in future will not be turned out as a conglomera-

tion of fibres, but that a new process will be developed whereby the threads are torn or cut by means of special equipment as they are continuously produced and are then spun while still lying parallel. A considerable number of such processes have already been described in patent literature. A staple fibre instructional spinning mill has been opened in Denkendorf for the purpose of studying all these processes and the spinning of staple fibre in general, where it is intended to carry out research on a large scale. (C)

Steam on Iron-weighted, Lead-weighted, Tin-weighted, Tin-lead-weighted and Zinc-weighted Silk Fabrics: Effect of. Rachel Edgar. *Iowa Agr. Expt. Sta., Ann. Rept.*, 1935, Pt. 1, P. 155–7; abs. in *C. A.*, 1938, V. 32, Col. 2362. (W)

Testing Knots. W. Frenzel and H. Bach. *Mell. Textilber.* (German ed.), 1938, No. 5, P. 413.

The authors carried out a large number of experiments with a view to determining the usefulness of these knots, more especially their strength. The cloth maker's knot does not greatly deteriorate the strength and elongation of air-dry viscose rayon; when wet, it has no effect at all. The worsted knot is the best for cuprammonium rayon. The knot has practically no influence upon the strength of single unsized cotton yarn. The weaver's knot on sized yarn showed the least number of breakages, as was also the case with four-ply cotton yarn. From 50 to 80% of the knotted threads in automobile tire cords broke; least breakage was observed when the worsted knot was employed. Generally speaking, it may be said that the weaver's knot proved to be one of the best in practically every test. (C)

Twist Yarn Fabrics. Influences of Right and Left Twist. "Bannockburn." *Wool Rec. & Text. Wld.*, Aug. 11, 1938, P. 26. (C)

200 Years After Paul. Anon. *Tex. Wld.*, June 1938, P. 69–84.

The story of his contribution, and that of Wyatt, to development of modern yarn manufacture, and a series of articles descriptive of a hypothetical modern textile mill. The series closes with the prediction "Ten years from now, due to research, this story will be obsolete in many of its particulars. Time marches on." (C)

Washing of Woolen Yarn and Piece Goods, and Mixtures of Wool and Staple Fibre. *Mell. Textilber.* (German ed), 1938, No. 8, P. 649.

According to the present state of our knowledge of the washing process, it is based upon three fundamental factors: wetting, emulsifying, and dispersing. The lowering of the surface tension of a washing liquor is to be regarded as being the first important requirement, because we are accustomed to work with aqueous liquors and water has the highest surface tension of all liquids known to us. Soap has several disadvantages: it is sensitive to hard water, metal salts, and acid; it is difficult to rinse out owing to hydrolytic decomposition; it is difficultly soluble, and it is inclined to cause sensitive goods to felt after having been washed for a comparatively short time. The latest types of synthetic detergents possess none of these drawbacks. These products ensure the maximum cleansing effect, compared with the properties of soap, when used for the washing of woolen and woolen mixture yarns and piece goods. When properly handled, it is possible to secure the very best results, not only in respect of cost, but also as regards the appearance of the goods, by the use of these agents. (C)

WATERPROOF RAYON FABRICS. H. Roche. *Text. Mfr.*, June 1938, P. 254–5.

An outline of new methods of waterproofing, a comparison of results, and methods of testing. (C)

WINDERS: GETTING THE MOST FROM. R. L. Chisholm. *Canadian Text. J.*, July 22, 1938, P. 29–31; *Tex. Wld.*, July 1938, P. 45.

Paper delivered at a meeting of the Textile Society of Canada (Western Div.) in Hamilton, Ontario, May 26, 1937. (C)

WOOL PROCESSING: STATISTICAL PROBLEMS IN. H. E. Daniels. *Text. Mfr.*, June 1938, P. 225–6, 236.

Refers to sampling methods that are being worked out to avoid difficulties in measuring wool properties and to measure variability. Analysis of variation in a card condenser has led to important practical conclusions. (C)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

ALIZARIN-RED DYEING: MECHANISM OF. R. Haller. *Helv. Chim. Acta*, 1938, V. 21, P. 302–8; abs. in *C. A.*, 1938, V. 32, Col. 3966.

A study of the sequence of steps in alizarin dyeing shows steaming to be an essential step which causes Ca and Al alizarinates to react to form a double salt which is dispersed in the polymerized fat acids produced from the Turkey-red oil. The salt is deposited on the fibres. This conclusion is confirmed by prepg. the system in glass, distributing the melt on a glass plate to form a pseudo-film which in dark-field illumination shows inhomogeneities under the microscope. (W)

COLOR: RELATIONSHIP OF pH TO. M. Déribéré. *Papier*, 1937, V. 40, P. 1005–18; abs. in *C. A.*, 1938, V. 32, Col. 3158.

An address explaining and discussing the effects of pH on the affinity of dyestuffs, on color and on fluorescence, and the effects of r_H on ordinary color and on fluorescent color. (W)

DYEING OF DAMAGED WOOL. *Wool Record & Tex. Wld.*, July 14, 1938, P. 86–8.

Discusses and explains the practical application of research work on this subject by Race, Rowe and Speakman, *J. Soc. Dyers Col.*, April 1938, P. 141–72. (C)

DYEING OF NATURAL SILK IN SKEINS WITH THE NAPHTHOLS AS. J. Senechal. *Rusta-Rayonne*, 1937, V. 12, P. 215–21; abs. in *C. A.*, 1938, V. 32, Col. 2359.

Details of the problems involved are given in the use of the various naphthols. Silk weighted with tin cannot be dyed with the dyes mentioned. (W)

DYEING PROPERTIES OF RAYONS: SOME ECCENTRICITIES IN THE. Anon. *Silk J. and Rayon Wld.*, Aug. 1938, P. 16, 19. (C)

DYEING OF WOOL-VISCOSE RAYON MATERIALS. H. Robinson. *J. Soc. Dyers Col.*, July 1938, P. 312–19.

Describes the dyes and dyeing methods suitable for wool-viscose rayon cloths, in which the rayon is used as a wool substitute and the finished cloth is to have all the characteristics of an all-wool cloth. (C)

ETHANOLAMINES: CHEMICAL NOTES ON. J. Wakelin. *Text. Col.*, June 1938, P. 373–5.

A review covering their many potentialities and uses in dyeing and finishing. (C)

FORMATION OF ALIZARIN RED. H. E. Fierz-David. *Helv. Chim. Acta*, 1938, V. 21, P. 432; abs. in *J. Soc. Dyers Col*, July 1938, P. 347.

R. Haller has described (*Helv. Chim. Acta*, 1938, *21*, 302–8) the formation of the aluminium-calcium lake of Alizarin during the steaming process. Fierz-David contends that this is not the normal course of the dyeing process, and concludes that the aluminium and calcium ions are first fixed on the fibre by conversion into soaps, are next converted during dyeing into calcium and aluminium alizarates in varying proportions, and thence into the red complex on steaming. It is necessary that both the calcium and aluminium ions should be present in excess for the red complex to be formed quantitatively. On account of its insolubility, low energy and symmetrical structure, this complex is regarded as the end product. (C)

"FORMULATION" OF DYEING RECIPES. Anon. *Text. Mfr.*, June 1938, P. 251, 256.

Notes on the formulation method of dyeing acid colors on woolen and worsted piece goods. (C)

ISOTHERMAL EQUATION OF DYEING. E. Kawada. *J. Soc. Chem. Ind. Japan*, 1937, V. 40, No. 12, P. 472; abs. in *C. A.*, 1938, V. 32, Col. 2754. (W)

LATEX: IMPREGNATION OF TEXTILES WITH. J. C. Bongrand. *Gummi-Ztg.*, 1938, V. 52, P. 180–1; abs. in *C. A.*, 1938, V. 32, Col. 2779, 3661. (W)

MERCERIZING: AUXILIARY CHEMICAL COMPOUNDS USED IN. L. P. Michel. *Tiba*, 1937, V. 15, P. 291–9, 367, 555–9, 609–13; abs. in *C. A.*, 1938, V. 32, Col. 787, 2363.

Excluding phenolic compds., it has been shown in recent years that some substances resulting from the replacement of O by S, according to the general formula RSR′, have greater wetting and penetrating power. A table is given showing the shrinkages of fibre by the use of phenol, chlorinated phenol, cresol, chlorinated xylenol; the latter gives the greatest shrinkage. Polyalcoholic and trialcoholic ethers are also discussed. (W)

NAPHTHOL AS SERIES: STUDIES IN THE. Part I.—Fastness to Kier-boiling. *J. Soc. Dyers Col.*, May 1938, P. 209–15; R. B. Forster, P. R. Mehta and K. Venkataraman. Part II.—Fastness to Rubbing R. B. Forster, S. R. Ramachandran, and K. Venkataraman. *Ibid.*, P. 216–25. (C)

"PERMANENT FINISHES" FOR TEXTILE FABRICS. PART I. DEFINITION, HISTORY AND DEVELOPMENT; THE HEBERLAIN PROCESS. PART II. SYNTHETIC RESIN AND THE ALKALI-SOLUBLE CELLULOSE ETHER METHODS. J. Andrew Clark. *Cotton*, 1938, July, P. 45–8; Sept., P. 53–6. (C)

IV. Research Methods and Apparatus

Mercerized Staple Fibre: Detection. E. Schneider. *Klepzig's Textil-Z.*, 1938, V. 41, P. 182; abs. in *J. T. I.*, May, 1938, P. A299. (C)

Neocarmin W. and B. Fibre Stains: Application. *Silk and Rayon*, 1937, V. 11, P. 1004, 1094; abs. in *J. T. I.*, March 1938, P. A166.

Directions are given for the use of Neocarmin stains in the identification of fibres and a list is given of the colors displayed by the various natural fibres and rayons and by oxycellulose. (C)

Methylcellulose (Tylose) on Yarns and Fabrics: Determination and Recognition of the Presence of. R. Brauckmeyer and F. Brühl. *Mell. Textilber.* (*German ed.*), 1938, No. 6, P. 518.

The authors describe a process by means of which the presence both of water-soluble as well as of alkali-soluble types of methyl-cellulose can be demonstrated on yarns and fabrics. It is based upon the discovery that cellulose ethers of that kind practically completely absorb direct dyes in a very short time even from very dilute solution at ordinary temperature and without the addition of salt. (C)

Oil, Soap and Other Extraneous Matter in Textile Materials: Methods of Determining. III. Investigation of the Nature of the Material Obtained by the Extraction of Commercially Clean Wool with Ethyl Ether. Bertil A. Ryberg. *Am. Dye. Rptr.*, April 4, 1938, P. 180–3.

"One of the laboratory tests used to determine the efficiency of the mill cleaning process for raw or greasy wool, is an extraction test using ethyl ether, or carbon tetrachloride. The amount of material extracted indicates the efficiency of the cleaning process. The material obtained is assumed to be residual wool grease, residual oils from those added during processing, and any free fatty acids from any source. Our work has shown that the composition of this ether extractable material is approximately the same, regardless of the method used to clean the wool. It appears, in our case, to be made up of some free acids plus a large amount of esters, presumably of the higher alcohols, the general composition being similar to that of wool grease. The ether extractable material obtained for this work appeared to be entirely residual wool grease in both cases, any oil used in processing being entirely removed in backwashing. It appears that oils added during processing are more easily removed in subsequent scouring operations, than residual wool grease retained from the original raw stock scour." (C)

Oxycellulose Research. J. Dumas. *Rev. gen. mat. Color.*, 1937, V. 41, P. 381–2; abs. in *Paper Trade J.*, May 12, 1938, P. 48. (C)

pH in Dyeing: Measurement of. M. Deribéré. *Tibia*, 1938, V. 16, P. 67–73; abs. in *J. T. I.*, June 1938, P. A347.

A survey of recent progress in potentiometric and colorimetric methods of measuring pH in dyeing. (C)

PHYSICAL AND CHEMICAL TEXTILE TESTING. VIII, PART 1, PHYSICAL TESTING. STRENGTH AND STRETCH TESTING OF FIBRES, YARNS AND FABRICS. John H. Skinkle. *Am. Dye. Rptr.*, May 2, 1938, P. 236–8, 247–51. (C)

RAW COTTON, MERCERIZED COTTON AND RAYON: MOISTURE RELATIONS. W. C. Schaposchnikov and W. A. Lepetov. *Sbirnik Inst. chem. Techn., Akad. Nauk, U.S.S.R.*, 1937, No. 5, P. 89–121 (through *Chem. Zentr.*, 1938, i, P. 1266); abs. in *J. T. I.*, June 1938, P. A361.

In the "air-dry" state, raw cotton (C), mercerized cotton (M) and rayon (R) prepared from the same cellulose contained 6.80, 9.78 and 12.60% of moisture, respectively; in a saturated atmosphere the values were 13.69, 21.54 and 24.95%. The time required to reach equilibrium in the saturated air was (C) 167.5, (M) 185.5 and (R) 220 hours. The mean time required for the uptake of 1% of moisture (from the slope of the curves) was (C) 24.31, (M) 17.22 and (R) 17.90 hours, but the difference in rate of regain between cotton and rayon was more striking in the initial period from zero to the air-dry state. Here cotton required 4.88 hours to increase by 1% but rayon required 13.17 hours. (C)

RAYON AND ARTIFICIAL WOOL: MOISTURE REGAIN STANDARD. Chamber of Commerce, Roubaix. *Bull. Trimestr. Lab. Analyses et Recherches Ind.*, 1938, No. 37, P. 4–8; abs. in *J. T. I.*, April 1938, P. A229.

Difficulties that arise over the regain of rayon, especially in mixtures with wool, are discussed. It is pointed out that in an atmosphere at 18° C. and 65% R.H. where the regain of wool is 17% and that of cotton 8½%, the regain of viscose rayon is 14½%. The accepted figure of 11% for rayon corresponds with 49% R.H. Moreover, the rate of regain of the artificial fibres is slower than for the natural fibres. The Roubaix Chamber of Commerce has therefore issued a circular on the subject (reproduced in the present report) and decided that in the future, in the absence of instructions to the contrary, the regain of regenerated cellulose rayon shall be taken as 14½% when wool is reckoned at 17%, and 16% when the regain of wool is 18¼%. For "Lanital" and "Celta" the regain is the same as for wool, and for acetate rayon 6% is taken. (C)

ROTATING ROPE: VIBRATION. C. E. Wright. *Phil. Mag.*, 1938 (vii), V. 25, P. 387–8; abs. in *J. T. I.*, April 1938, P. A250.

Stevenson's problem of the vibrations in a rope when whirled at high speed round a vertical axis is considered and solutions of the equations for the steady state are presented. The changes in tension are also discussed. (C)

ROTATING THREAD: FORM ASSUMED IN WINDING. H. W. Hall and W. Hunter. *Phil. Mag.*, 1938 (vii), V. 25, P. 193–234; abs. in *J. T. I.*, April 1938, P. A250.

The form assumed by a steadily rotating thread is treated mathematically. The general solution of the equations of motion of a thread in steady rotation with angular velocity ω is expressed in terms of Weierstrassian elliptic functions, air resistance being neglected. The two cases are dealt with when the thread passes through an eyelet on the axis of rotation and

supports a hanging mass and when the axis of rotation is vertical and the thread supports a mass hanging freely. Calculated results are compared with observations on "ballooning" yarns which may be taken as giving extreme limits for the range of instability. (C)

RESISTANCE EXTENSION IMPACT TESTER: DESCRIPTION. W. L. Balls. *Min. Agric. Egypt, Tech. Sci. Service, Bull.* No. 194, 1938, pp. 19.

A detailed description is given of an impact tester for cotton hairs that instead of merely indicating the breaking force in work units measures both resistance and extension. The outstanding feature is the employment of three separate pendulums, identical in period and in phase, each with its special purpose: (1) the cradle, to present the test material to the arresting anvil, and to prevent rebound therefrom, (2) the hammer, or ballistic pendulum proper, and (3) the recorder, carrying a drum on which a stylus connected to the hammer traces their relative movements, and hence the velocity or energy of the hammer in terms of their relative displacements. (C)

V. ECONOMIC RESEARCH AND MISCELLANY

PURIFICATION OF AQUEOUS EFFLUENTS. I. DYE LIQUORS. L. Fassina. *Chim. et Ind.*, 1937, V. 38, P. 116–23T; abs. in *J. Soc. Dyers Col.*, March 1938, P. 125.

An account of the types of impurities present in dyehouse effluents and the processes available for their clarification, decantation and filtration, is followed by an illustrated description of an electrolytic apparatus which has proved most successful in their purification by a continuous process. In the clarification process itself, the liquors are agitated with argil and lime or ferric sulphate, agitation being effected by means of the gaseous bubbles liberated in the voltmeter. The argil and ferric sulphate retain not only suspended impurities, but a large proportion of dissolved basic dyes and alkaloids. The liquors are then decanted and filtered, and decolorized by passing through a series of cylinders connected to one another by means of a horizontal pipe, fitted with stopcocks so as to enable any particular cylinder to be put out of action when necessary. The cylinders contain different absorbents, *e.g.*, acidified non-resinous wood fibre for the removal of basic dyes and basified wood fibre for the removal of acid dyes. (C)

STRENGTH OF NITROCELLULOSE SOLVENTS: COMPARATIVE TOLUENE DILUTION RATIOS OF PURE SOLVENTS AND SOLVENT-COUPLER MIXTURES. A. K. Doolittle. *Ind. Eng. Chem.*, Feb. 1938, P. 189–95. (S)

STRUCTURE OF PROTEINS: CATTLE HEMOGLOBIN, EGG ALBUMIN, CATTLE FIBRIN, AND GELATIN. M. Bergmann and C. Niemann. *J. Biol. Chem.*, March 1937, P. 301–14; abs. in *Eastman Kodak Abs. Bull.*, Feb. 1938.

Calculations of molecular weights from the analytical data on the amino-acid residues in various proteins are presented. Since gelatin is heterogeneous, no conclusive results on this protein are obtainable. The "periodicity" of each amino-acid residue is discussed with regard to the Svedberg unit. (S)